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(71) Applicant: DURA PHARMACEUTICALS, INC. [US/US]; 7475 Lusk Boulevard, San Diego, CA 92121-4204 (US).

(72) Inventors: BOYLES, James; 11460 Wills Creek Rd., San Diego, CA 92131 (US). GANEM, Charles; 1 Key Way, Cape Neddick, ME 03902 (US). WOODWORTH, Daryl; 65 Earles Road, South Berwick, ME 03908 (US). DAMECKI, Chester; 17851 Old Winery Way, Poway, CA 92064 (US). WITHAM, Clyde, L.; 13728 Paseo Bonita, Poway, CA 92064 (US).

(74) Agent: OHRINER, Kenneth, H.; Lyon & Lyon LLP, 633 West Fifth Street, Suite 4700, Los Angeles, CA 90071-2066 (US).

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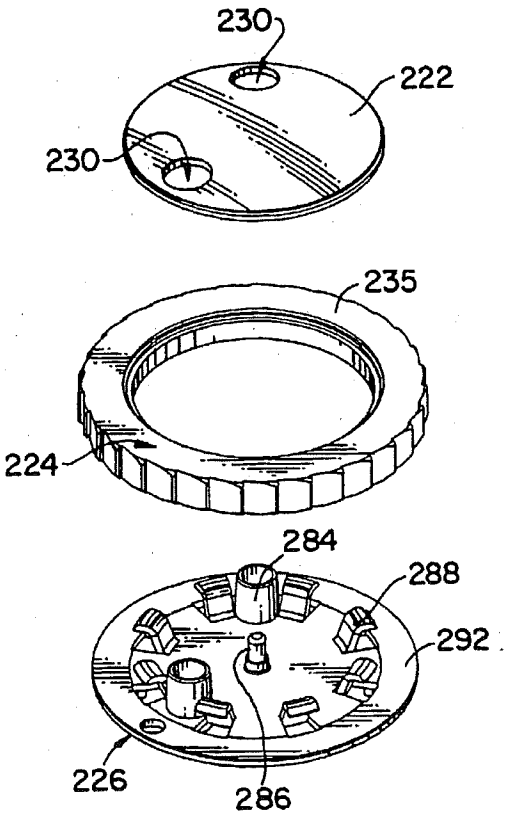
(54) Title: DRY POWDER INHALER



(57) Abstract: A dry powder pharmaceutical is contained within a cassette (220) attached to an inhaler. The cassette (220) includes a dose ring (224) with apertures (248) for holding the dry powder. A seal disk (226) has clamping arms (288) which clamp onto the dose ring, to seal the powder within the apertures in the dose ring. A double cassette (300) has two cassettes (302, 304) attached together back-to-back to provide a larger number of doses.

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— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DESCRIPTION

Dry Powder Inhaler

Background of the Invention

Field of the Invention

The field of the invention is inhalers. More specifically, the invention relates to cassettes or containers for storing dry powder pharmaceuticals, for use with inhalers.

Inhalers are used to deliver drugs into a patient's lungs. Typically, an inhaler contains or provides a mixture of drugs and air or propellants. The mixture is delivered via the patient inhaling from a mouthpiece on the inhaler, for treatment of various conditions, for example, bronchial asthma. However, delivery of drugs via inhalation can be used for many other treatments, including those unrelated to lung conditions.

Inhalers have used various techniques for storing drugs to be delivered. Some inhalers have used bulk drug storage reservoirs and mechanisms for dividing out individual doses with each use. Other inhalers have used separately contained drug doses, such as in U.S. Patent Nos. 4,778,054 and 5,327,883.

The inhaler, described in U.S. Patent No. 5,327,883 uses individual medicine doses stored within a plurality of apertures in a dry powder pharmaceutical containing cassette. The cassette is manually advanced to deliver successive doses. However, while this and other devices have met with varying degrees of success, disadvantages still remain in storing and delivering dry powder pharmaceuticals from a cassette, and in reliably delivering a precise quantity of drug from the cassette.

Accordingly, it is an object of the invention to provide an improved cassette for storing and delivering dry powder pharmaceuticals.

Statement Of The Invention

To this end, a multi-dosage powder containing cassette has individual powder pharmaceutical dosages radially spaced apart in a dose ring. A seal disk has clamping arms which hold the dose ring and seal disk together. The seal disk seals the powder within the dose ring.

Other and further objects will appear hereinafter.

Brief Description Of The Drawings

In the drawings, wherein similar reference characters denote similar elements throughout the several views:

Fig. 1 is an exploded perspective view of the cassette of the invention;

Fig. 2 is a section view thereof;

Fig. 3 is a perspective view of the bottom of the cap shown in Fig. 1;

Fig. 4 is a top perspective view thereof;

Fig. 5 is a bottom perspective view of the dose ring shown in Fig. 1;

Fig. 6 is a top perspective view thereof;

Fig. 7 is a top perspective view of the seal disk shown in Fig. 1;

Fig. 8 is a bottom perspective view thereof;

Fig. 9 is a section view of the dose ring shown in Fig. 1;

Fig. 10 is an enlarged detailed view of the dose container shown in Fig. 9;

Fig. 11 is a perspective view of a second cassette embodiment;

Fig. 12 is a top view thereof;

Fig. 13 is a partial section view taken along line 19-19 of Fig. 12;

Fig. 14 is a section view taken along line 20-20 of Fig. 12;

Fig. 15 is an enlarged detail of a section of Fig. 14.

Fig. 16 is a top view of a tool used to assemble the cassette shown in Fig. 1;

Fig 17 is a side view thereof; and

Figs. 18-22 are enlarged partial section views showing the steps used to assemble the cassette shown in Fig. 1.

Detailed Description Of The Embodiments

Turning now in detail to the drawings, as shown in Figs. 1 and 2, a cassette 220 has a dose ring 224 attached to a seal disk 226. A cap 222 may optionally be provided on top of the dose ring 224, opposite from the seal disk 226.

Referring now to Figs. 5, 6, 9 and 10, the dose ring 224 has an inner flat surface 240. An annular first top step 242 and an annular second top step 244, concentric to and within the first top step 242, are located on the top surface 235 of the dose ring 224.

A center bore 245 extends through the dose ring 224. A bottom step 246, located on the bottom surface 237 of the dose ring 224, is concentric with the first top step 242.

A plurality of radially spaced apart dose containers 248 are formed in the bottom surface 237 of the dose ring 224. Each of the dose containers 248 has an open end 250 and a blind or closed bottom 252. The open ends 250 of the dose containers 248 are located on a flat annular land area 258 formed between the bottom step 246 and a raised outer rim 256.

A plurality of saw teeth 264 are provided around the outer perimeter of the dose ring 224, with one saw tooth associated with each dose container 248. In the embodiment shown, 31 dose containers 248 are formed in the dose ring 224. For pharmaceuticals taken one dose per day, the dose ring 224 provides a one month supply.

Turning to Figs. 7 and 8, the seal disk 226 has a top surface 280 and a bottom surface 282. A smooth and flat annular seal ring 292 is formed around the outside of a center plate 278. A single dose hole 295 extends through the seal ring 292. Tubes 284 pass through the center plate 278, with tube extensions 296 extending slightly below the bottom surface of the center plate, as shown in Fig. 8. The tubes 284 and tube extensions 296 are provided so that the cassette 220 can be properly mounted on the inhaler. as described in U.S. Patent No. 6,006,747. A center pin 286 extends upperly from the center of the center plate 278. A plurality of clamping arms 288 are radially spaced apart and extend upwardly from the top surface of the center plate 278. An opening 290 is formed under each of the clamping arms 288, to simplify injection molding of the seal ring.

On the bottom surface 282 of the seal disk 226, feet 294 extend downwardly between each of the clamp arm openings 290. Bottom pins 298 extend downwardly from the bottom surface of the center plate 278. As the cassette 220 is thinner than the cassette 60, the feet 294 and the pins 298 are provided so that the cassette 220 can be used interchangeably with the cassette 60, in the same inhaler. As shown in Figs. 7 and 8, the cap 222 has a cap post bore 234 adapted to fit over the center pin 286 on the seal disk 226.

The cap 222 also has cap holes 230 located and dimensioned to fit over the top end of the tubes 284.

Referring to Fig. 2, in the assembled cassette 220, the land area 258 of the dose ring 224 is clamped against the seal ring 292 of the seal disk 226, via the clamping arms 288 clamping down on the second top step 244 of the dose ring 224. The clamping force exerted by the clamping arms 288 is sufficient to hold the dose containers 248 tightly against the seal ring 292, to largely prevent a dry pharmaceutical powder held in the dose containers 248 from leaking out. The clamping force is advantageously applied by the clamping arms very close to the containers 248. However, the clamping force still permits the dose ring 224 to be incrementally rotated or indexed, to bring each of the dose containers 248 sequentially into alignment with the dose hole 295, so that the dry pharmaceutical powder contents of each dose container 248 can be released into the inhaler.

The seal disk 226, dose ring 224 and cap 222 are preferably made from Lexan plastic. The cassette 220 as shown in Fig. 1 is preferably assembled by first filling the dose containers 248 with pharmaceutical dry powder, with the dose ring 224 upside down. The seal disk 226 is then pressed onto the dose ring 224. The clamping arms 228 momentarily are deflected radially inwardly as they pass through the center bore 245 of the dose ring 224 and then flex back outwardly to engage the second top step 242. The cap 222 is then pressed onto the center pin 286 of the seal disk 226. The edges of the cap 222 are located on the first step 242 on the top of the dose ring.

The steps for assembling the seal disk 226 to the dose ring 224 are shown in sequence in Figs. 18-22. Initially, the seal disk is placed upside down in a fixture or holder 410, as shown in Fig. 18. A mandrel 400 is then brought down on top of the seal disk 226, as shown in Fig. 19. The mandrel 400, as shown in Figs. 16 and 17, has legs 402 projecting from a disk section 406. The mandrel 400 is oriented so that the legs 402 align with the openings 290 in the seal disk 226. Preferably, the assembly is performed in batches, with an array of e.g, 9 seal disks 226 positioned within an array of 9 holders 410. An actuator or automation element 404, such as a robot arm, is attached to the disk section 406 of the mandrel 400.

Referring to Figs. 19 and 20, the mandrel is pushed down onto the seal disk 226. As this occurs, a chamfered inner edge 408 on each leg of the mandrel engages an outer leg surface 291 at each of the clamping arms 288. In the embodiment shown, there are 8 clamping arms, and 8 legs on the mandrel, although other numbers may be used as well. The outer leg surface 291 extends downwardly and outwardly (from the center of the seal disk) as shown in Figs. 7 and 19-22.

As the mandrel 400 moves down, it pushes each clamping leg 288 down, displacing the outer edge 289 of each arm downwardly and inwardly, from the position A to position B as shown in Fig. 20. The clamping legs are now in a temporarily retracted position. The amount of displacement is relatively small, yet it is sufficient to allow the clamping legs to pass freely through the dose ring 224. In a typical application, the arm edge 289 is displaced both vertically downwardly and inwardly by e.g., 0.25- 1.0 mm, and preferably by about 0.75 mm . The clamping legs 288 are sufficiently resilient to allow this displacement without adverse effects. The holder 410 supports the seal disk all around against the downward force of the mandrel.

The mandrel 400 stops moving relative to the seal disk when the chamfered inner edge 408 of each leg of the mandrel reaches the radius joining the arm edge 289 to the rest of the leg 288. Referring to Fig. 2`, the mandrel 400 next retracts or lifts up, while still fully engaged onto the seal disk 226, lifting the seal disk up and off of the holder 410. The mandrel 400, carrying the seal disk (or the array of mandrels and seal disks) then moves over, preferably via automation, into vertical alignment with a dose ring 224 supported on or in a second holder 412. The dose ring 224 is filled with pharmaceutical powder. The mandrel 400 is then moved down, with the seal disk 226 passing through the central bore or opening 245 in the dose ring 224. As shown in Fig. 21, the arms on the seal disk 226 pass freely through the dose ring, because they are deflected inwardly by the legs 402 of the mandrel 400.

As shown in Fig. 22, after the seal disk is moved through the central opening 245 in the dose ring 224, the mandrel 400 lifts up, while the seal disk is held down onto the dose ring by a cylinder push rod 414, which extends down through the mandrel during this step. As the mandrel 400 lifts up, the clamping arms 288 move back into their original positions. The edges of the clamping arms move up and clamp onto the second step 244

of the dose ring. This occurs smoothly and with no abrupt snapping movement, so that the powder pharmaceutical in the dose ring is not disturbed or scattered. The clamping arms hold the seal disk 226 and the dose ring 224 together, into a cassette assembly, as described above. While the seal disk 226 does not provide a total, e.g., gas-tight or hermetic seal, it does efficiently keep the powder from escaping out of the dose ring.

In another embodiment 300, shown in Figs. 11-15, a first cassette 302 has a first seal disk 306, and a second cassette 304 has a second seal disk 308. The cassettes 302 and 304 are the same as the cassette 220, described above, except that the first cassette 302 has retainer spring fingers 310 extending upwardly from the center plate of the first seal disk 306. Hooks 312 extend radially outwardly on the retainer spring fingers 310. The center plate of the second seal disk 308 of the second cassette 304 has hooks slots 314. The hooks 312 on the retainer spring fingers 310 engage the hook slots 314, to hold the second cassette 304 on top of the first cassette 302, providing a two layer cassette 300, having twice as many doses as the single cassette 320.

In use, the cassettes 220 and 300 are installed and used with the inhaler in the same way as the cassette described in U.S. Patent No. 6,006,747. With the double cassette 300, the saw teeth on the first cassette 302 and second cassette 304 are vertically spaced apart sufficiently so that the advancing mechanism of the inhaler advances only the bottom cassette (the dose ring on the top cassette remaining in a fixed position). After all of the doses in the bottom cassette are delivered, the double cassette 300 is removed from the inhaler, turned over, and reinstalled, so that the cassette on the bottom becomes the cassette on top, and vice versa. Accordingly, the double cassette 300 is able to deliver a larger number of doses.

The invention resides as well in subcombinations of the devices and methods described. The features shown and described may also be shared among the embodiments, as desired.

Claims

1. A cassette for use with a dry powder inhaler, comprising:

a dose ring having:

an annular dose ring body ;

an inner surface and an outer surface, and a top surface and a bottom surface, on the annular dose ring body, the inner surface defining a center bore;

a plurality of ridges equally spaced apart around the outer surface of the dose ring body;

a plurality of dose containers formed in the top surface of the dose ring body, with the dose containers equally spaced apart from each other, and with each dose container having an open top end and a closed off bottom end; and

a seal disk attached to the dose ring, the seal disk having:

a center plate having a top surface and a bottom surface;

a seal ring joined to the center plate and overlying the open top ends of the dose containers of the annular dose ring body, and a dose hole passing through the seal ring; and

a plurality of clamping arms extending from the top surface of the center plate and engaging the top surface of the dose ring body, the clamping arms holding the dose ring and the seal disk together.

2. The cassette of claim 1 further comprising a pair of tubes attached to the center plate and extending from the top surface of the center plate through the center bore of the dose ring body wherein the pair of tubes engage the inside surface of the annular dose ring body.

3. The cassette of claim 2 wherein the inside surface of the dose ring body is flat.

4. The cassette of claim 1 further comprising a cap at the top surface of the dose ring body, with the cap having a cap post attached to a center pin on the top surface of the center plate of the seal ring.

5. The cassette of claim 4 further comprising a pair of cap holes in the cap, with the tubes extending into the cap holes.

6. The cassette of claim 1 further comprising a first annular step on top surface of the annular dose ring body, and an annular bottom step on the bottom surface of the annular dose ring body.

7. The cassette of claim 6 further comprising a second annular step on the top surface of the annular dose ring body, with the second annular step centered within the first annular step.

8. The cassette of claim 1 wherein the dose ring is rotatable on the seal disk via sequentially engaging each of the ridges.

9. The cassette of claim 1 further comprising a raised outer annular rim at the perimeter of the top surface of the annular dose ring body, with the raised outer annular rim surrounding the outer perimeter of the seal ring on the seal disk.

10. The cassette of claim 1 further comprising a clamping arm opening through the center plate of the seal disk under each of the clamping arms.

11. The cassette of claim 1 further comprising a foot on the bottom surface of the center plate of the seal disk, between each of the clamping arm openings.

12. A cassette for use with a dry powder inhaler, comprising:

a dose ring body;

a plurality of dose containers in the dose ring body, with each dose container having an open end;

a seal disk attached to the dose ring and covering the open first ends of the dose containers of the dose ring body; and

clamping features on the seal disk engaging the dose ring body, for holding the dose ring and the seal disk together.

13. The cassette of claim 12 wherein the dose ring body is annular.

14. The cassette of claim 12 further comprising a plurality of ridges equally spaced apart around an outer surface of the dose ring body.

15. The cassette of claim 12 further including a dose hole passing through the seal disk.

16. A cassette assembly for use with a dry powder inhaler, comprising:

a first cassette, and a second cassette, each one having

a dose ring having a first surface and a second surface; and

a plurality of dose containers formed in the first surface;

a seal disk attached to the dose ring, the seal disk having a plurality of clamping arms engaging the first surface of the dose ring body, the clamping arms holding the dose ring and the seal disk together; and

the first cassette further including fingers engaging the second cassette, for holding the first and second cassettes together.

17. The cassette of claim 12 with the dose containers also having a closed end opposite to the open end.

18. A method of manufacturing a cassette for use with a dry powder inhaler, comprising:

filling dose containers in a dose ring with a dry powder;

aligning a seal disk on a mandrel over the dose ring;

pushing the mandrel against the seal disk to temporarily displace clamping devices on the seal disk and provide clearance for the clamping devices to pass by the dose ring; and

releasing the mandrel from the seal disk, and allowing the clamping devices to move back toward their original positions, and clamp onto the dose ring, to hold the dose ring and the seal disk together.

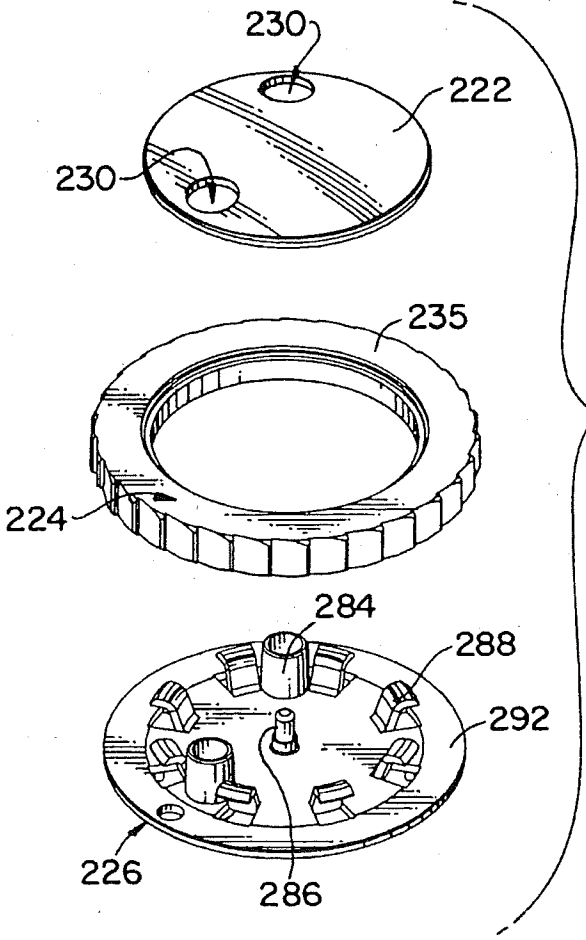
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Fig. 1

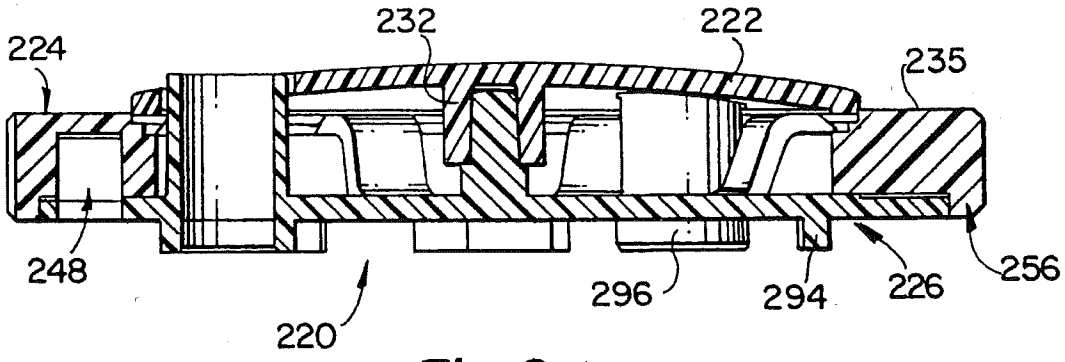
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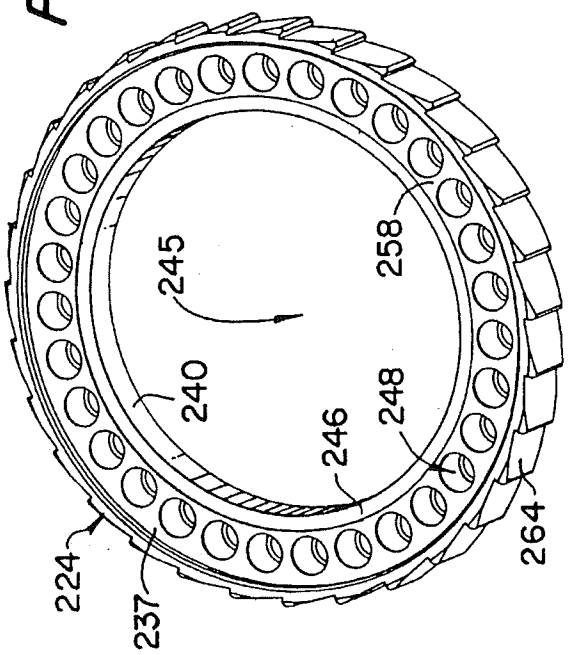
Fig. 2

Fig. 5



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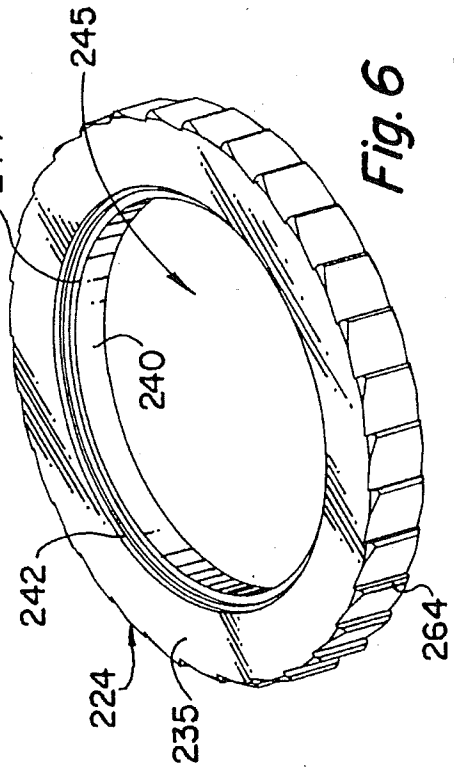


Fig. 3

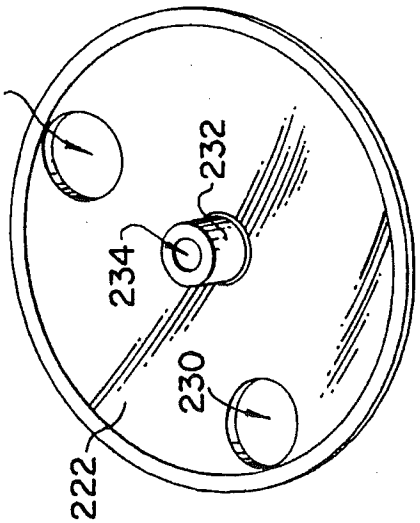
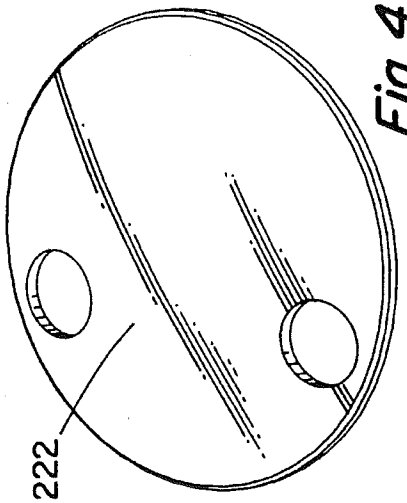


Fig. 4



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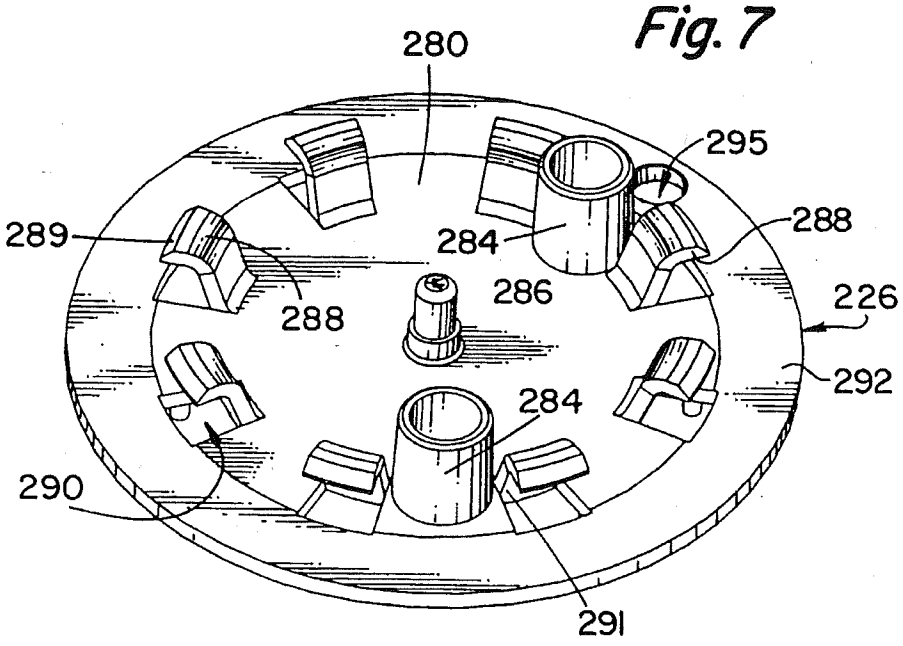
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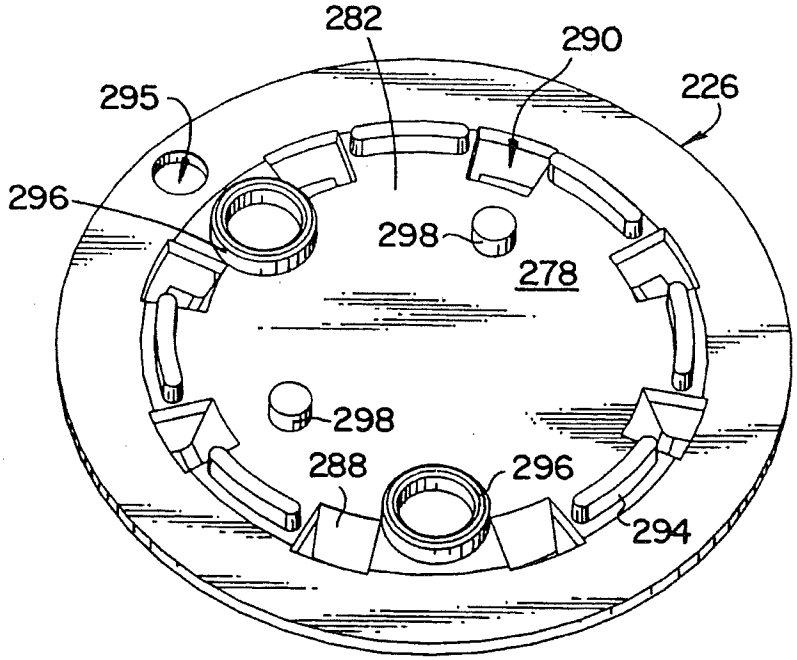
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Fig. 8

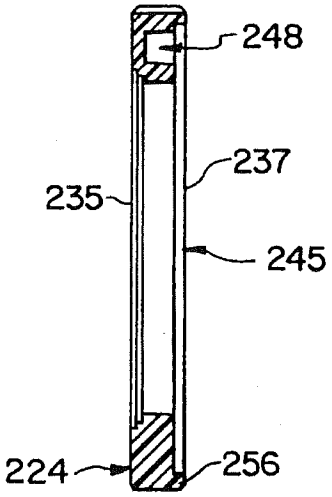


Fig. 9

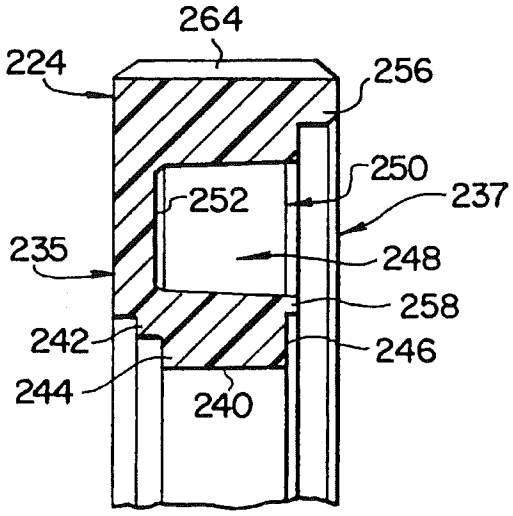


Fig. 10

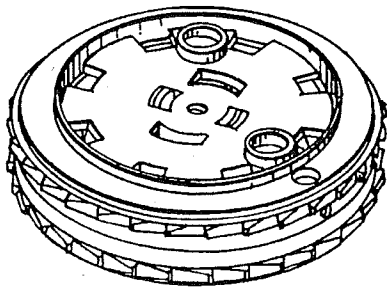


Fig. 11

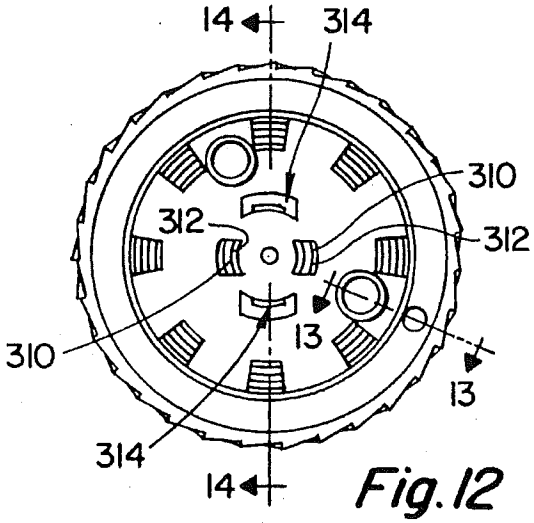


Fig. 12

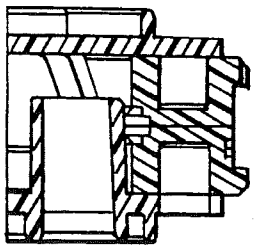


Fig. 13

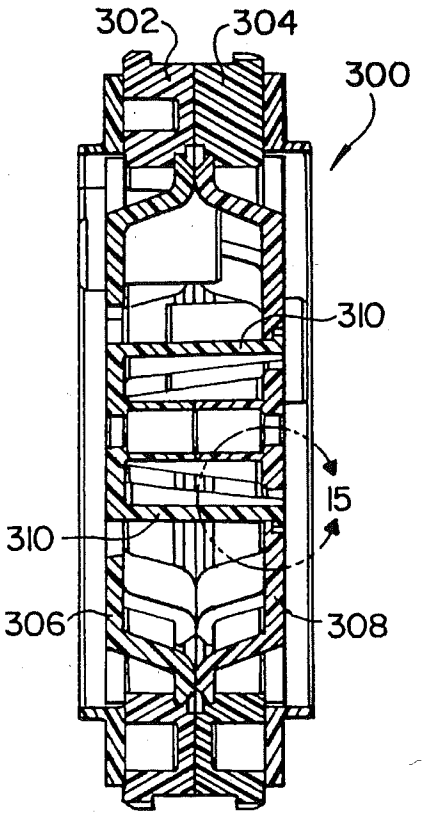
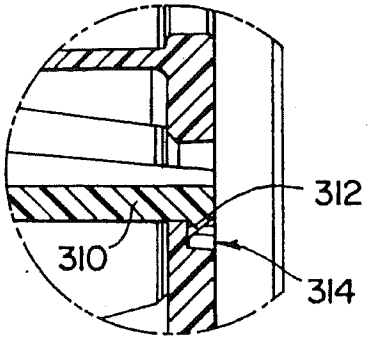


Fig. 14



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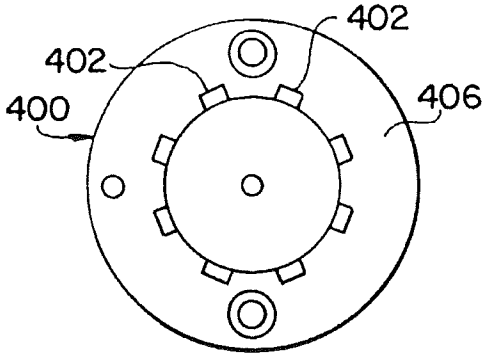


Fig. 16

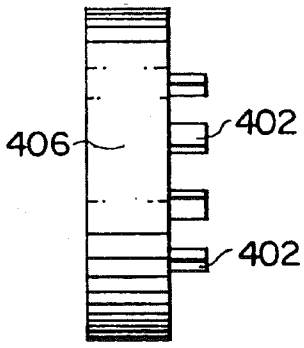
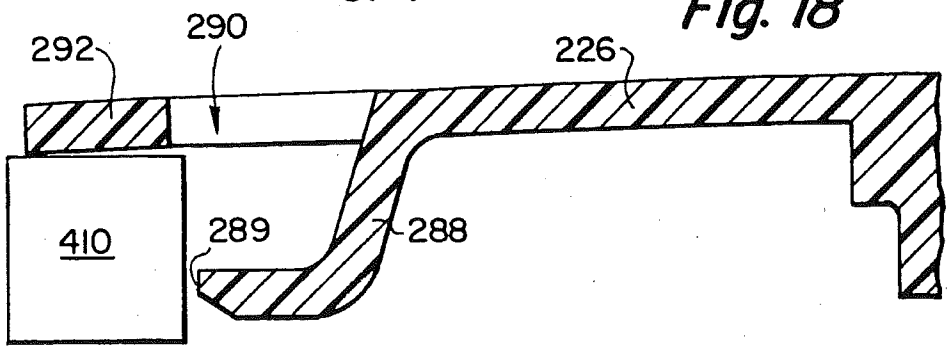


Fig. 17

Fig. 18



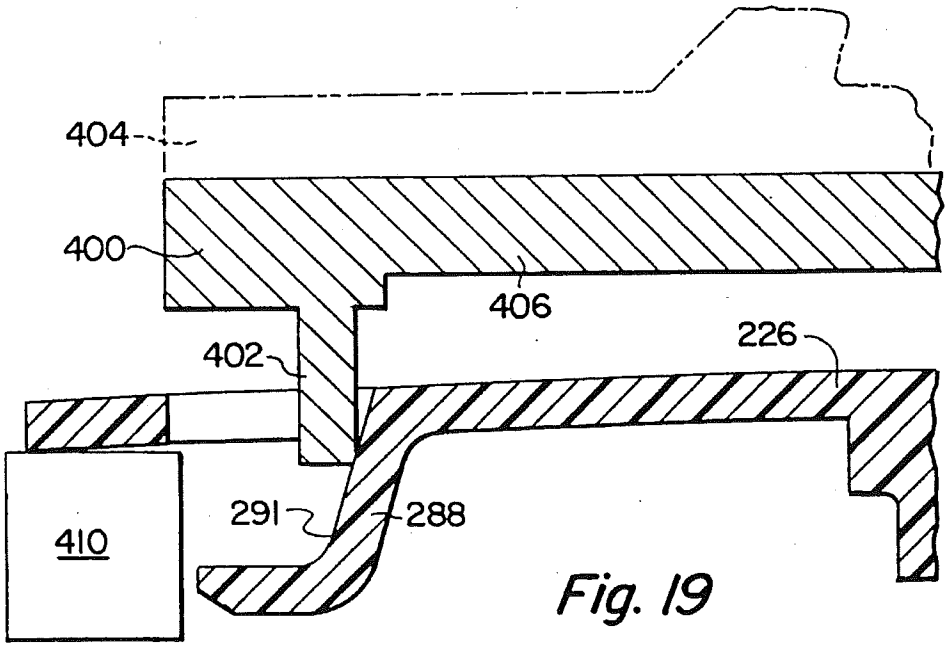


Fig. 19

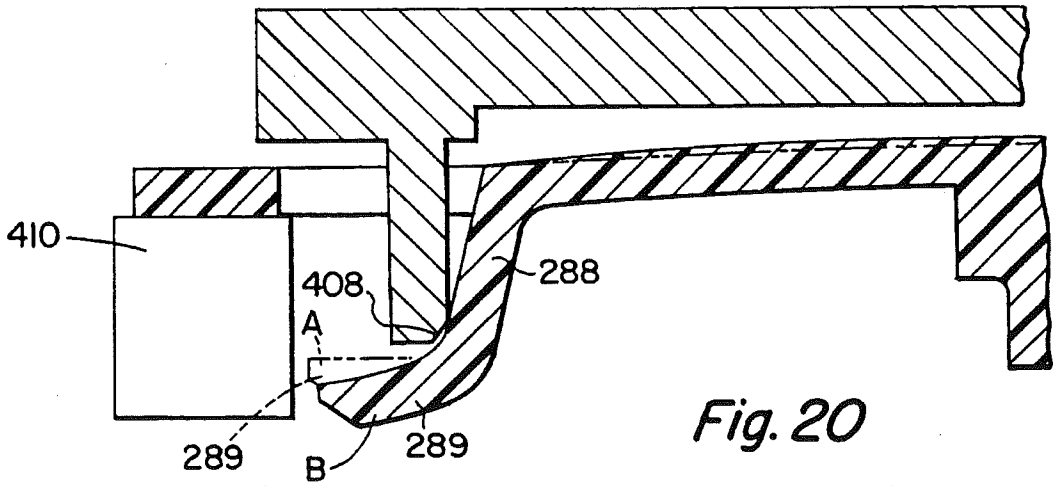
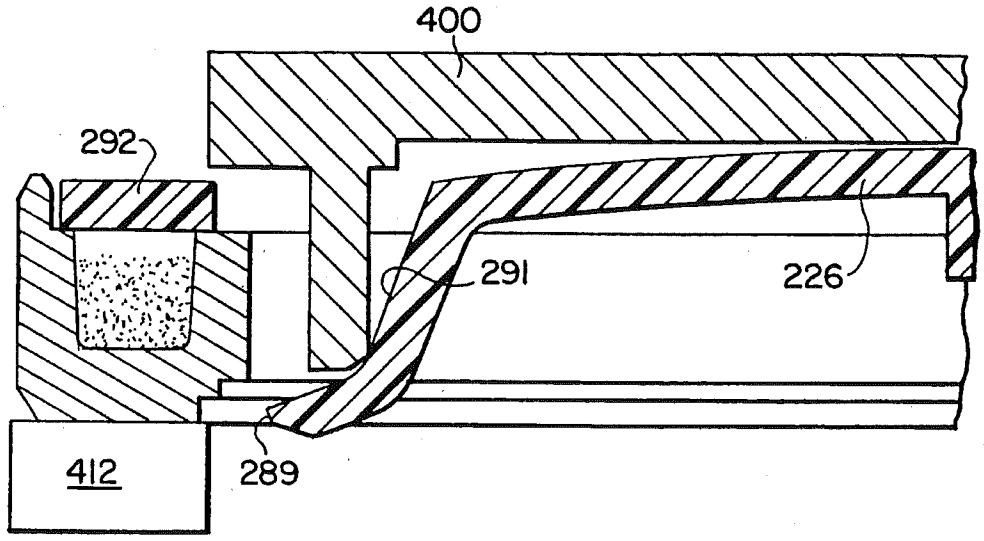


Fig. 20

Fig. 21



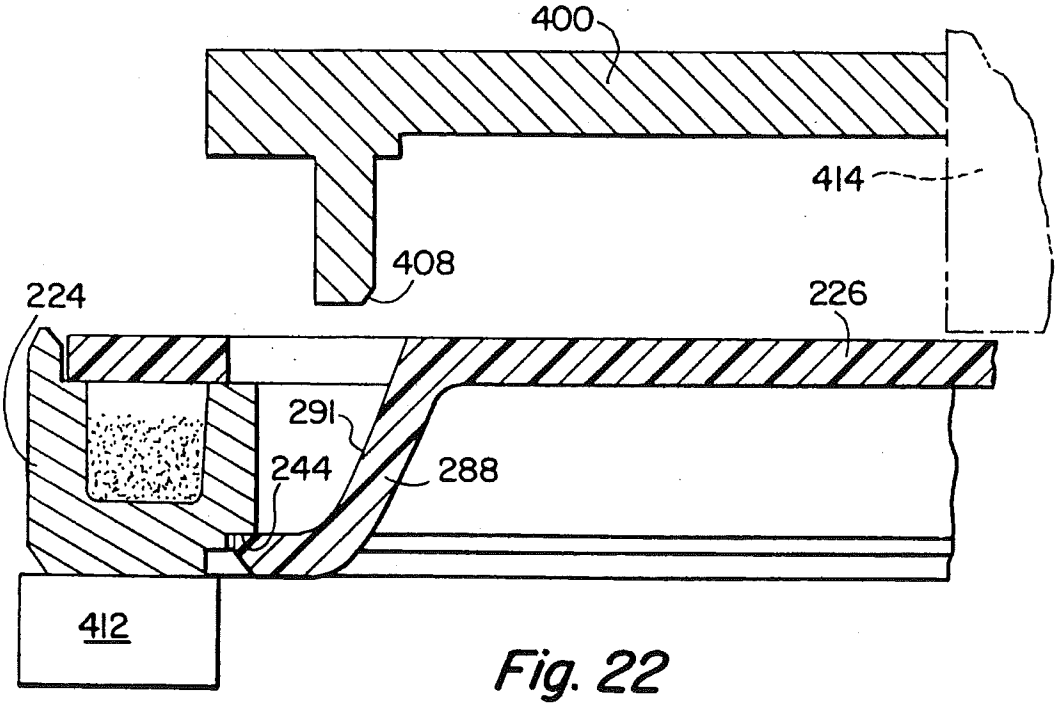


Fig. 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/29392

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61M 15/00; B65D 83/04

US CL : Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/203.12, 203.15, 203.19, 203.21; 206/532, 533, 535, 538, 540, 438; 220/4.24, 504, 507

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,604,559 A (McCALL) 14 September 1971, see entire document.	1, 8, 12-15
A, P	US 6,116,238 A (JACKSON et al.) 12 September 2000.	1
A, P	US 6,006,747 A (EISELE et al.) 28 December 1999.	1
A	US 5,921,237 A (EISELE et al.) 13 July 1999.	1
A	US 5,035,237 A (NEWELL et al.) 30 July 1991.	1
A	US 3,638,830 A (BELOKIN, JR.) 01 February 1972.	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 30 DECEMBER 2000	Date of mailing of the international search report 26 JAN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer MITAL B. PATEL Telephone No. (703) 308-0858

Form PCT/ISA/210 (second sheet) (July 1998) ★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/29392

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

128/203.12, 203.15, 203.19, 203.21; 206/532, 533, 535, 538, 540, 438; 220/4.24, 504, 507